

Postings: from the desk of Jim Brodrick

In last week's *Posting* I answered some questions about solid-state lighting standards, but this week I'd like to address another question that gets asked often enough to warrant not only a *Posting* of its own, but an upcoming webcast as well. More about that webcast at the end of this *Posting*, but first here's the question: People say they've been hearing a lot of hype about LED linear replacement tubes, and they wonder whether those products are legitimate.

The question is a good one, because along with all the hype, there's a great deal of confusion out there on the subject. That's why DOE has been tracking LED linear replacement lamps very closely through the [CALiPER testing program](#) for quite some time now – and the picture that emerges isn't a pretty one. A [CALiPER Benchmark Report](#) published early last year compared the performance of T12 and T8 fluorescent lamps and troffers with LED linear replacement lamps, and concluded that "LED technology is not yet ready to displace linear fluorescent lamps as replacement light sources in recessed troffers for general interior lighting." Strong wording, but it's based on a number of key CALiPER benchmark observations.

One of these observations involved light output. Although LED linear replacement lamps are marketed as one-for-one drop-in retrofits for general fluorescent applications, CALiPER found that their light output was only one-third to one-half that of the fluorescent lamps they were designed to replace. Even though luminaire efficiencies (fraction of light escaping the luminaires) were higher with LED linear replacements (because the inherent directionality of LEDs reduces

the amount of light trapped in the luminaires), low lumen output and low lamp efficacy limited overall performance to levels that were significantly below fluorescent systems. This meant that to maintain existing light levels (not just directly beneath the luminaires), additional LED replacement lamps would have to be installed – which would not only decrease potential energy savings but would require additional luminaires or modifications.

What's more, the CALiPER benchmark testing found that troffers fitted with LED replacement lamps had narrower light distribution, which could compromise illumination uniformity and vertical illumination in existing installations. And several other potential problems with LED linear replacement lamps were also noted. Three of the four LED products tested required bypassing the fluorescent ballast, which would require additional labor when retrofitting luminaires. On the other hand, efficacy was lower and ballast input wattage can be uncertain for replacement lamps that utilize the existing fluorescent ballast. And two of the four products had a very cool color appearance, with CCT values exceeding ANSI tolerances (>7000 K), which means they wouldn't integrate well with existing lighting systems.

The latest round of CALiPER testing, Round 9, reinforced the benchmark findings. Round 9 results, which were published in November, showed that the linear replacement LED lamps tested fell far short of T8 fluorescent lamps in terms of both light output and efficacy, even when tested in troffers for overall luminaire performance. While the LED replacement products had roughly 10%-15% less luminaire loss than their fluorescent counterparts when installed in troffers, this difference didn't compensate for the lower light output of the LED replacement lamps. And none of the replacement products tested in any CALiPER round to date has matched the T8 fluorescent benchmark troffers for luminaire efficacy. What's more, Round 9 results showed once again that the LED products had poorer color quality and often required rewiring of the troffer to bypass the ballast (which could jeopardize the luminaire's

UL/CSA/ETL listing).

Two additional issues must be considered. First, LED T8 replacement lamps cost much more than fluorescent lamps. Prices vary, but most LED T8 replacement lamps cost between \$50 and \$150 each, compared to about \$3 for a fluorescent T8 lamp. Second, long-term performance data for LED T8 replacements is not available, so there is very little evidence to support the life claims for these products. Many LED T8 replacements claim 35,000- to 50,000-hour life based on 70% lumen maintenance. Fluorescent T8 lamps have typical rated lives of 24,000 to 36,000 hours, depending on the switching frequency and type of ballast used. Considering that end-of-life lumen maintenance for fluorescent T8s is roughly 92%, is there any life advantage to LED T8s?

As the CALiPER Benchmark Report points out, fluorescent systems have their own performance issues – including diminished performance at low temperatures, as well as disposal issues due to their mercury content. So there may be some niche applications where LED linear replacements make sense. But in general, as the [CALiPER Round 9 Summary Report](#) concludes, they "do not represent wise use of SSL technology at this time."

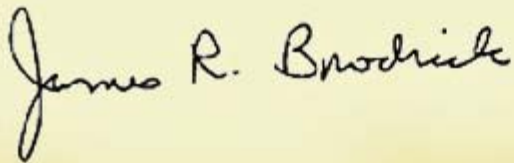
The problem is compounded by inaccurate performance claims on the part of manufacturers. Most of the manufacturers of SSL linear replacement lamps tested in Round 9 provided incorrect data, with some promising as much as 50% more lumens than their products actually delivered. In the same vein, claims for lm/W ran 30%-50% higher than what CALiPER testing measured, and CRIs in general were found to be lower than what was claimed.

By contrast, a number of 2'x2' LED fixtures tested in Round 9 roughly matched their fluorescent equivalents for light output and efficacy, and one even surpassed the efficacy of a 2'x4' fluorescent parabolic luminaire. Why the big performance difference between these 2'x2' LED fixtures and the LED 4' linear replacement lamps?

The answer is that SSL technology works most efficiently when luminaires are designed for LED light sources, as was the case with the 2'x2' LED fixtures. Fluorescent luminaires simply weren't designed to dissipate heat or to distribute light from LED 4' linear replacement lamps.

As you can see, making the right decisions about LED linear replacement lamps and integral LED fixtures can be a tricky matter, which is why DOE is offering a webcast this week on the subject. Entitled "LEDs for Interior Office Applications," the webcast will run from 1:00 to 2:30 p.m. Eastern Time this Thursday (March 18). It's a great opportunity to take a "guided tour" of this complex topic by experts from Pacific Northwest National Laboratory, as well as to ask questions. To register for the webcast, or for more information, visit www1.eere.energy.gov/buildings/ssl/events_detail.html?event_id=4163.

As always, if you have questions or comments, you can reach me at postings@lightingfacts.com.



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